

## Studies in the Hawaiian Rutaceae, IV New and Critical Species of *Pelea* A. Gray<sup>1</sup>

BENJAMIN C. STONE<sup>2</sup>

THE FOLLOWING NOTES, including descriptions of four proposed new species, are the partial outcome of monographic studies of Hawaiian genera. *Pelea* is a genus confined to the Hawaiian and Marquesan archipelagoes, with all but two of its species endemic to the Hawaiian Islands. There are four relatively natural sections of the genus, characterized primarily by features of the mature fruits and to a lesser extent by leaf arrangement. Systematic treatment of section *Pelea*, which includes the type species, *Pelea clusiaefolia*, is completed. The following notes apply to sections *Apocarpa*, *Megacarpa*, and *Cubicarpa*, as defined by the writer (Stone in Degener, 1962). Related studies have recently appeared or are now in press (Stone 1962a, 1962b, Stone in Degener, 1962). Casual collecting of species of *Pelea* was begun by the author in 1955; in 1958 and 1959 and summer, 1961, intensive field and herbarium studies were carried out. Through the courtesy of the U. S. National Herbarium, Smithsonian Institution, loans of historically important collections were obtained, and I am grateful to Dr. H. R. Fletcher, of the Royal Botanic Gardens, Edinburgh, Dr. George Taylor of the Royal Botanic Gardens, Kew, Dr. J. E. Dandy of the British Museum (Natural History), Dr. Alicia Lourteig of the Museum d'Histoire Naturelle, Paris, Dr. Richard A. Howard of the Arnold Arboretum of Harvard University, and Dr. A. J. Eames of Cornell University for their aid. I am particularly indebted to the former Director of the Bishop Museum, Dr. Alexander Spoehr, Botanist Marie C. Neal, and Curator of Collections E. H. Bryan, Jr., for their generous assistance.

The following comments are arranged by generic section.

<sup>1</sup> The greater part of this work was accomplished at the University of Hawaii and at the U. S. National Herbarium. Manuscript received February 27, 1962.

<sup>2</sup> College of Guam, Agaña, Guam.

### SECTION *Apocarpa* STONE

1. *Pelea ovata* St. John & Hume in Lloydia 7: 272, 1944.

*P. Forbesii* St. John & Hume, l.c. Syn. nov.

Examination of the holotype specimens shows that the pubescence which is found on *Forbesii*, the type of *P. Forbesii*, is not constant, but is found only on one leaf, perhaps from an abnormal cause. It has been noted that leaf-galls of other species, even ordinarily glabrous ones, will often be densely puberulent. Even the new leaves and buds of *P. Forbesii* are found to be glabrous. Since no other character or combination of characters appears to distinguish this from *Pelea ovata*, it is concluded that but one species is represented. Since the description of *P. ovata* calls for glabrous leaves, and since there is no question of priority involved, both descriptions first appearing on the same page of the publication, the name *P. Forbesii* is relegated to synonymy.

*Pelea ovata* is a vinelike shrub endemic to the island of Kauai.

2. *Pelea hawaiiensis* Wawra in Flora 56:110. 1873.

*P. cinerea* var.  $\gamma$  Hillebrand, Fl. Haw. Ids. 69, 1888; Rock, Indig. Trees Haw. Ids. 239, 1913 (in part, excluding Oahu plants).

*P. cinerea* var. *hawaiiensis* (Wawra) Rock in Bot. Gaz. 65:265, 1918.

A tree with smooth light-brown bark, opposite leaves, and generally pubescent innovations; the pubescence of fulvous or reddish hairs, rarely pale; petioles, twigs, and leaves sometimes soon glabrate, commonly with a more or less persistent indument; inflorescences usually densely puberulent, or tomentose, cymose, with generally 3 to 27 flowers, axillary; flowers with deltoid acute thick tomentellous sepals; petals deltoid-

lanceolate, tomentellous, often reddish within; stamens glabrous; ovary densely tawny or golden tomentellous; style hirsutulous; stigma dark maroon, glabrous; capsule commonly 16–34 mm broad, often subtended by the persistent sepals, the carpels with a dense persistent fulvous or reddish pilosity; endocarp firm, thickly pilose with pale hairs.

TYPE: Hawaii: Kawaihae-iuka, in 1862, Wm. Hillebrand (in the Wawra Herbarium, Vienna). A photo shows capsules 27 mm broad.

(a) var. *hawaiiensis*

The typical variety, which is certainly distinct from *Pelea cinerea*, as was stated (in herb.) by the late C. N. Forbes, is nonetheless a southeast counterpart of that species. The distribution of

the typical variety includes Hawaii and Maui. Other varieties, some of them eminently distinct, others only poorly differentiated, are found on Hawaii, Maui, Lanai, and Molokai.

(b) var. *rubra* (Rock) B. C. Stone, comb. nov.

*P. cinerea* var. *rubra* Rock in Bot. Gaz. 65: 264, 1918.

*P. oblongifolia* var.  $\beta$  Hillebrand, Fl. Haw. Ids. 65, 1888.

*P. cinerea* var.  $\delta$  Rock, Indig. Trees Haw. Ids. 239, 1913.

*P. cinerea* var.  $\delta$  Hillebrand, op. cit. 69. (as to Kau specimen).

Hillebrand tells us that this is a glabrous shrub with long rambling branches. The poorly

#### KEY TO VARIETIES OF *Pelea hawaiiensis*

Capsules mostly 27–34 mm diameter (rarely smaller); inflorescences often few-flowered (3–9).

Leaves puberulent beneath, at least on the costa, at first (and often persistently) uniformly tomentellous to pilose; inflorescence compact, with stout axes, peduncles ca. 2 mm thick, densely tomentellous; capsular pubescence fulvous to brownish-orange. Hawaii.....

.....var. *hawaiiensis*

Leaves glabrous, glossy; inflorescences elongate, the axes slender, peduncle to 1 mm thick, glabrous or nearly so; capsular pubescence reddish. Hawaii.....

.....var. *rubra*

Capsules smaller, mostly 16–22 mm diameter; inflorescences mostly compact and multiflorous with 9–27 flowers, or rarely more open and with fewer flowers.

Blades densely shaggy-pilose beneath, short-lanceolate; branchlets puberulent; inflorescences mostly 3–9-flowered.

Blades cordate at base; tomentum fulvous, the hairs extremely minute. Molokai.....

.....var. *molokaiana*

Blades subcuneate to rounded at base; tomentum brownish or olivaceous, the hairs up to 0.7 mm long. Maui, Lanai.....

.....var. *pilosa*

Blades tomentellous to glabrate beneath, sometimes at last glabrous; inflorescence several- to many-flowered (with up to 27 flowers), or less commonly only 3–7-flowered.

Inflorescences mostly only 3–7-flowered.

Blades cordate or emarginate at base, slightly puberulent on the costa dorsally, elongate and often acuminate. Lanai.....

.....var. *sulfurea*

Blades cuneate at base, glabrate to glabrous beneath, rather broad, ovate. Maui.....

.....var. *Brighamii*

Inflorescences mostly 9–27-flowered.

Blades cordate or subcordate at base, or sometimes merely emarginate; inflorescences about 4–6 cm long.

Blades glabrate beneath; petioles mostly 20–45 mm long. Maui.....

.....var. *Remyana*

Blades puberulent beneath; petioles mostly 7–18 mm long. Maui.....

.....var. *racemiflora*

Blades cuneate or rarely slightly emarginate at base; inflorescences compact, 2–3 cm long; costa puberulent or glabrous dorsally. Hawaii.....

.....var. *Gaudichaudii*



developed capsule of the specimen which he described (with a question mark) as a variety of *Pelea oblongifolia* (a species of sect. *Megacarpa*) misled him; on closer examination, it can be seen that only one follicle is developed, and it is thus difficult to ascertain whether the fruit is apocarpous or syncarpous. However, the tomentum of both the follicle and the endocarp, as well as the leaf venation, suffice to establish the relationship of this plant with *P. hawaiiensis*, rather than with the similar *P. cinerea* of Oahu (which has pubescent endocarp but glabrous follicles), or the greatly different *P. oblongifolia* of Hawaii (with glabrous endocarp and sparsely puberulent syncarpous capsules).

TYPE: Hawaii: North Kona; Huehue, lava-beds, 6 June 1909, *Rock 3565* (Bishop).

Distribution: Kona and Kaū, Hawaii; Olowalu, Maui.

SPECIMENS EXAMINED: Maui: Central ridge of Olowalu valley, 12 May 1920, *Forbes 2345.M.* (Bishop). Hawaii: North Kona, Puuwaawaa, 6 June 1909, *Rock 3561* (Bishop). Kaū, *Hillebrand 251* (Kew), *252* (Kew), without number (Kew). Kaū Desert, 2 August 1911, *Forbes 385.H.* (Bishop).

(c) var. *pilosa* St. John in *Lloydia* 7:272, 1944.

*P. cinerea* β var. *Hillebrand*, *Fl. Haw. Ids.* 69, 1888 (as to Lanai specimens with pilose blades).

This variety is limited to Lanai and Maui. Hillebrand's description is based mostly on the Lanai specimen, although he cites *Mann & Brigham 371* from Makawao, Maui. This is a misprint for 377; Hillebrand wrote 377 on the label of his own collection as a note citing the Mann and Brigham specimen for comparison; but their specimen is a different variety (var. *Brighamii*). Rock erred in calling his Maui specimens the same, and, after coining the name *sulfurea*, applied it to both the Hillebrand and the Mann and Brigham specimens; var. *sulfurea* is restricted to Lanai. Unfortunately, the type of var. *pilosa* was destroyed at Berlin during World War II.

SPECIMENS EXAMINED: Maui: South slope of Haleakala, March 1920, *Forbes s.n.* (Bishop); Auahi (Auwahi), March 1920, *Forbes 2099.M.*, *2098.M.*, *2097.M.*, *2115.M.*, and *s.n.* (Bishop).

(d) var. *molokaiana* B. C. Stone, var. nov.

Folia base cordata, infra fulvo-pilosa.

HOLOTYPE: Molokai: Ridge below Puu Kolehokole, July 1912, *Forbes 126.Mo.* (Bishop; isotype at US).

DISTRIBUTION: Restricted to Molokai.

The innovations are densely tawny-hirsutulous; blades lance-ovate, rounded or acute at apex, subcordate to cordate at base, up to 8 × 3.5 cm, with petioles densely hirsutulous, as are the lower surfaces of the blades.

(e) var. *sulfurea* (Rock) B. C. Stone, comb. nov.

*P. cinerea* var. *sulfurea* Rock in *Bot. Gaz.* 65: 265, 1918.

*P. sulfurea* (Rock) St. John & Hume in *Lloydia* 7:274, 1944.

TYPE: Lanai: Without locality, July 1870, *Hillebrand* (Kew; isotype, Bishop).

DISTRIBUTION: Restricted to Lanai. Abundant collections are in the Bishop Museum Herbarium.

(f) var. *Brighamii* (St. John) B. C. Stone, comb. nov.

*P. Brighamii* St. John in *Lloydia* 7:271, 1944 (sub sect. *Cubicarpae*).

TYPE: Maui: Makawao, *Mann & Brigham 377* (Bishop, GH).

DISTRIBUTION: Maui.

Described as a species but, no doubt through a typographic error, misplaced under section *Cubicarpae*. This is the variety that Rock had in mind when he discussed var. *sulfurea* (in *Bot. Gaz.* 65:265, 1918), although he did not typify that variety, but left Hillebrand's original intent as applying to Lanai plants.

A number of specimens have been seen, mostly from Makawao, Olinda, and Olowalu.

(g) var. *Remyana* B. C. Stone, var. nov.

Arbor, innovationibus dense fulvo-hirtellis; foliis maturis supra glabris infra glabris costa media sparse puberulo vel glabrato exceptis, laminis 5–16 cm longis, 2–6.5 cm latis, subanguste ellipticis, apice rotundatis vel emarginatis, base subcordatis vel cordatis (vel emarginatis); inflorescentiis 15–21 (–27–) floriferis; capsulis

densa fulvo-puberulentibus, c. 20 mm diametro; endocarpio hirtello.

HOLOTYPE: Hawaii: Without definite locality, *Jules Rémy* 626 (Paris).

DISTRIBUTION: Known only from Hawaii.

(h) var. *racemiflora* (Rock) St. John in *Lloydia* 7:272, 1944.

*P. cinerea* var. *racemiflora* Rock, Indig. Trees Haw. Ids. 241, 1913.

TYPE: Maui: Auahi, on aa lava, at about 1500 feet alt., November 1910, *Rock* 8676 (Bishop).

DISTRIBUTION: Maui.

SPECIMEN EXAMINED: Maui: Pakiloi forest, March 1920, *Forbes* 2082.M. (Bishop).

(i) var. *Gaudichaudii* (St. John) B. C. Stone in *Pac. Sci.* 16:369-371, 1962.

*P. Gaudichaudii* St. John in *Lloydia* 7:272, 1944.

*brunelia sandwicensis* Gaud. nom. nud. in *Bot. Freycinet Voy. in obs.* 1826.

TYPE: 'Sandwich Islands,' *Gaudichaud* (Paris; fragment at Geneva).

DISTRIBUTION: Hawaii, especially around Kilauea and vicinity.

3. *Pelea makabae* B. C. Stone, sp. nov.

Arbor; innovationibus minute puberulentibus; foliis maturis infra dense cinereis, laminis olivaceis, trichomiis ad 0.1 mm longis, cum squamulis interspersis; petiolis 10-22 mm longis, 1-2 mm crassis, glabrescentibus; laminis anguste ovatis vel ellipticis, rare late lanceolatis, coriaceis, ca. 3.5-12 cm longis, 1.5-5 cm latis, base cuneatis, apice subacutis; inflorescentiis axillaribus, cymosis unifloris (vel trifloris?), axibus cinereis, ad 12 mm longis, binodosis; floris ignotis; sepalis caducis; capsulis 20-24 mm diametro lobis discretis follicularibus glabris punctatis, apice minute mucronulatis; endocarpio glabro.

HOLOTYPE: Oahu: Waianae Mountains, Makaha Valley, near top of ridge, at about 4000 ft. alt., 21 October 1954, *Gordon A. Pearsall* s.n. (Bishop).

A characteristic species closely allied to and simulating *P. cinerea*, but with glabrous endocarp; similar also to *P. cinereops* but with glab-

rous ovary. The disk may however be slightly puberulent.

The cinereous indument is extremely fine, composed of waxy scales intermingled with hairs less than 0.1 mm long, obscuring the densely glandular-punctate surface of the lamina. The indument tends to persist on the younger petioles and stems, also. The leaf margins are usually very slightly inrolled; the lateral nerves are ascending, parallel, and united by a sinuate marginal nerve 1-8 mm or more in from the edge.

#### SECTION *Megacarpa* STONE

4. *Pelea Balloui* Rock, Indig. Trees Haw. Ids. 228, 1913.

*P. ukuleleensis* St. John (as to flowering branch of type sheet), in *Lloydia* 7:267, 1944. Syn. nov.

The type specimen of *P. ukuleleensis* is a mixture of two species: the flowering material is from a plant of *P. Ballouii*; fruits of *P. clusiae-folia* are mounted on the same sheet. Hence the species is based on mixed material, of which both elements already bear valid names, and the name *ukuleleensis* is relegated to synonymy.

The type of *P. Balloui* is: Maui: Haleakala, trail from Ukulele to Waikamoi Gulch at ca. 5000 ft. alt., 25 October 1910, *Rock & von Tempisky* 8609 (Bishop).

The type sheet of *P. ukuleleensis* is: Maui: Ukulele, July 1919, *Forbes* 749.M. (Bishop).

4. *Pelea Hiiakae* B. C. Stone, sp. nov.

Arbuscula; innovationibus minute puberulentibus glabratibus; foliis, petiolis, ramulisque glabris; petiolis filiformibus 9-21 mm longis, 1 mm crassis; laminis ellipticis base cuneatis vel subrotundatis apice obtusis vel rotundatis, 3.5-6.5 cm longis et 2-3.5 cm latis, glabris, costa media anguste dorsaliter salientis brunneis, nervis lateralibus paralleliter ascendentibus, cum nervio sublineare a margine distans 1 mm coalitis; inflorescentiis axillaribus 2-3-nodosis, ad 3.5 cm longis in fructu, axibus glabris, pedunculis 3-8 mm longis, in crassitudine petiolo aequis, pedicellis claviformibus, sub calyce expansis; cymis unifloriferis; floris ignotis; capsulis ca. 25 mm diametro profunde ( $\frac{2}{3}$ - $\frac{3}{4}$ ) lobatis lobis



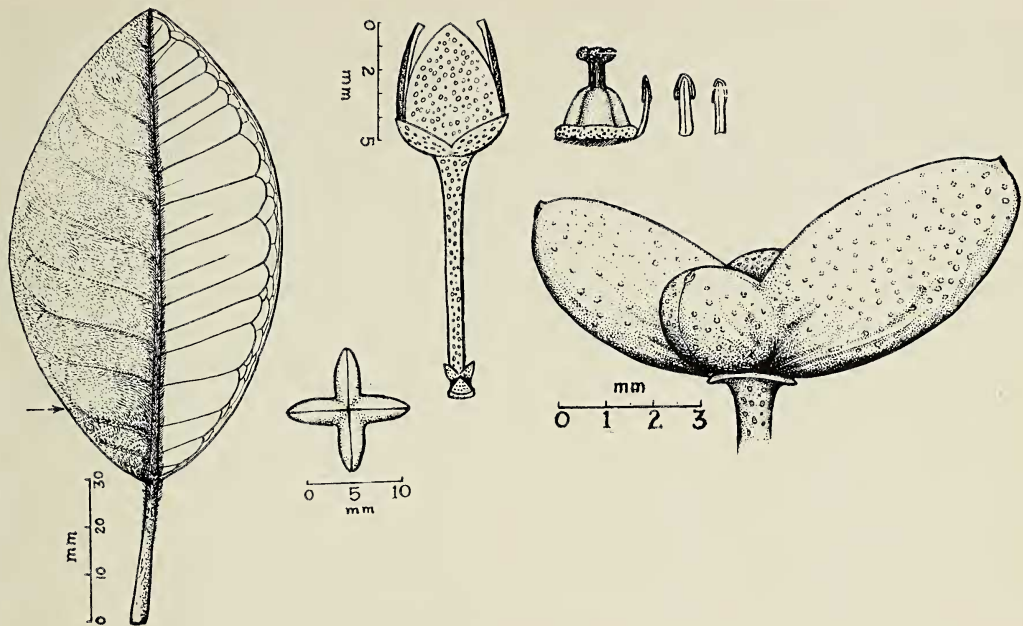


FIG. 1. *Pelea kauaiensis* H. Mann. Holotype specimen, Mann & Brigham, Cornell Univ. Herb. A leaf, showing pubescence and venation of lower surface; a flower (the entire 1-flowered inflorescence), showing the glandular-punctate appearance; floral parts; immature capsule in side view; and reconstructed conjectural top view of a mature capsule.

rotatis; exocarpiis ad basim sparse puberulentibus glabrescentibus; endocarpio sparse hirtello trichomiis ad suturas dorsales aggregatis; lobis diseminatis; seminis ovoideis, ca. 5–6 mm longis; testa crustacea nigra nitida.

**HOLOTYPE:** Oahu: Koolau Range, Kipapa Gulch, Waipio, on southerly ridge in woods at 1800 ft. alt., 16 October 1932, Edward Y. Hosaka 809 (Bishop).

This species seems to be related to *Pelea descendens* St. John, which however is characterized by smaller capsules 13–17 mm in diameter, with glabrous exocarp and quite glabrous endocarp. *Pelea Hiiakae* is also related to *P. Wawraeana* Rock, which differs in that the pubescence of the endocarp is restricted to the innermost part of the sutures (and may sometimes be lacking), and in the more compact, shorter, multi-flowered pubescent inflorescences.

The species is named in honor of Hiiaka, youngest sister of the goddess Pele, heroine of the tales of Pele and Hiiaka.

It must be noted that this specific name was first applied to certain specimens from the island

of Kauai which were thought to represent an undescribed species (Stone 1626, Faurie 225, and Lydgate s.n.). Since doubt remains as to the fruiting state of these plants and their specific distinctness from *Pelea anisata*, they must remain undescribed. The name *Pelea Hiiakae* must now be borne by the Oahu plant described above, as this is the first publication of the name. Should the Kauai plants ultimately prove distinct, another name will be given to the species.

5. *Pelea kauaiensis* H. Mann Jr. in Proc. Boston Soc. Nat. Hist. 10:313, 1866.

Fig. 1

A small tree to 5 m high, with opposite leaves; innovations minutely but densely tawny-puberulent, but the branches quickly glabrate, at the 3rd or 4th node quite glabrous. Leaves distinctly petiolate, petioles 12–30 mm long, flattened ventrally and narrowly and shallowly channelled and nearly glabrous or with a few scattered minute trichomes at the margins; the rounded dorsal surface especially near the distal

end hirsute with trichomes 0.8–1.0 mm long; but the whole petiole glabrate and ultimately glabrous. Blades 5–10 cm long, 3–6 cm broad, elliptic, usually rounded at base, broadly subacute at apex or there minutely retuse, ventrally glabrous even in bud, densely villous beneath all over the dorsal surface and densely hirsute along the costa, with pale stramineous trichomes ca. 1 mm long, the indument more or less permanent; costa raised and rounded dorsally; lateral nerves 8–14 per side, nearly straight and parallel, the connecting marginal nerve deeply arched, with several minor veinlets intervening between it and the margin; marginal nerve ca. 2–8 mm from the edge. Inflorescence a highly reduced cyme with usually 1 or rarely 2 to 3 flowers, axillary among the leaves; peduncle and pedicel sparsely and minutely puberulent in flower, later subglabrate; peduncle reduced to a slight projection no higher than the 2 or 4 bractlets it bears, and hidden by them; pedicel ca. 5 mm long, 0.3–0.4 mm thick, slightly flaring at calyx to a breadth of 0.7–0.9 mm, with bractlets tightly appressed at base of pedicel on the obsolete peduncle; bractlets deltoid, ca. 0.3–0.4 mm long, opposite, decussate; pedicels and perianth segments copiously opaque-punctate. Pistillate flowers ca. 3 mm high, sepals broadly ovate with rounded summit and sharp apex, 1.3 mm long, 1.5 mm broad, glabrous except for the minutely ciliolate margins. Petals glabrous, broadly ovate, acute, 2–4 mm long, ca. 1.7 mm broad. Stamens sterile, all shorter than the style, in 2 subequal quartets, the shorter quartet just under 1 mm long, the longer quartet bare more than 1 mm long. Ovary 4-lobed, glabrous, ca. 1 mm high, 1.3 mm broad, on a glabrous shallow somewhat reddish-speckled disk, the style 0.5 mm high, stigma 4-lobed, ca. 0.7 mm broad, the lobes dark purplish and minutely papillate. Staminate flowers unknown. Immature capsule nearly 10 mm diameter, the lobes (some abortive) still more or less ascending, 5 mm long, deeply parted ( $\frac{4}{5}$ – $\frac{5}{6}$ ), sepals caducous; exocarp glabrous, copiously glandular-punctate; endocarp glabrous; lobes 2-seeded.

TYPE: Kauai: Waimea, 2000–3000 ft. alt., Mann & Brigham s.n. (Cornell).

DISTRIBUTION: Kauai.

Only one further collection of this species is known; it is from the general area of the type

locality (Waimea, Kauai) and was discovered by Otto Degener. Unfortunately, it is a sterile specimen.

This species has been consistently misinterpreted since its first description. Hillebrand (1888) described under the name *Pelea kauaiensis* a species superficially similar to that which Mann had actually described, but clearly distinct; Hillebrand's material was correctly segregated by Rock (1918) under the name *Pelea recurvata* Rock. In 1897 Heller described *Pelea cruciata*, which was however considered by later authors, such as Rock, to be a synonym of *Pelea kauaiensis* Mann. Such was not the case; Heller's species was justly distinguished, and is quite distinct from both *Pelea kauaiensis* or *Pelea recurvata*. Skottsberg (1944) noted the discrepancies between descriptions and specimens of these three entities, and published in tabular form some of their differences. Upon comparing type specimens of the three species it becomes quite apparent that they are distinct. The above extended description of *Pelea kauaiensis* is based on the original material, and should serve finally to clarify this least understood member of a trio of superficially similar species.

*Pelea kauaiensis* may be quickly distinguished from the two other species formerly confused with it as follows:

1. Endocarp glabrous.
2. Blades permanently pilose beneath; capsule lobes ascending or rotate; capsules 10–? (perhaps 20) mm diameter; inflorescence reduced, 1–3-flowered.....*kauaiensis*
2. Blades ultimately slightly glabrescent; capsule lobes recurved; capsules 21–23 mm diameter; inflorescence stout, 3–9-flowered.....*recurvata*
1. Endocarp pubescent; blades densely puberulent.....*cruciata*

Mann's original description indicated the name as *kawaiensis*; since, however, the Latin *v* is more commonly spelled out either as a true *v* or as *u* in modern usage, and since the *u* is essential to the meaning as well as the pronunciation of the name, it is thought best to retain with Hillebrand the name of the island in its correct form, as *kauaiensis*. See art. 73, note 6,



of the 1961 International Code of Botanical Nomenclature.

Little need be added to the descriptions of *P. recurvata* and *P. cruciata*, but it should be mentioned that Skottsberg 2865, commented upon by Skottsberg (1944) as *P. cruciata*, is actually a specimen of *P. recurvata*, as the endocarp is quite glabrous.

6. *Pelea Lakae* B. C. Stone, sp. nov.

Arbor ad 5 m alta, ramis divaricatis, trunco ad 5–10 cm diametro, innovationibus dense hirsutulis, trichomiis pallide albobrunneis adpressis ad 1 mm longis; petiolis ramulisque glabris; petiolis 10–65 mm longis, 1.5–3 mm crassis; laminis ellipticis vel subovatis vel subobovatis, coriaceis, 4–25 cm longis, 2.5–11 cm latis, base cuneatis vel obtusis, apice subacutis, obtusis vel subrotundatis, supra glabris, infra puberulentibus in pagine juvente glabrescentibus, costa media salientis stramineis vel brunneis puberulentis (trichomiis cum squamulis glaucis interspersis), nerviis lateralibus curvate ascendentibus in extremis cum nervo marginale arcuato 2–10 mm intra margine coalitis, reticulis venulosis minoribus intervenantibus; inflorescentiis axillaribus cymosis, cymis ad 2 cm longis axibus puberulentibus glabris, 2–4-nodosis, 3–5-floriferis, pedunculis 2–7 mm longis pedicellis ca. 3 mm longis; floris ignotis; bracteis deltoideis extus puberulentibus; capsulis maturis 22–32 mm diametro profunde ( $\frac{3}{4}$ ) lobatis lobis recurvatis pre- et postdehiscutionem et paullo reflexis, uni- vel diseminatis, base 8 mm altis, lateraliter compressis, apicem versus angustatis subfalcatis; exocarpio minutè denseque puberulento non-ruguloso; endocarpio glabro in suturam basem centralem excepto, trichomiis paucis aggregatis; seminis ovoideis, 5–6 mm longis, testa crustacea nigra nitida.

**HOLOTYPE:** Oahu: Koolau Range, Pupukea, at about 2000 ft. alt., at edge of small boggy region, 17 September 1961, B. C. Stone & A. K. Chock 3655 (Bishop; duplicates to be distributed).

A species reminiscent of *Pelea recurvata* of Kauai, but with a puberulent rather than glabrous ovary, and a few hairs clustered near the innermost angles of each suture on the endocarp.

The specific name honors Laka, goddess of the hula.

7. *Pelea Lobiauana* B. C. Stone, sp. nov.

Fig. 2

Arbuscula? ramis virgatis elongatis, innovationibus ramulis petiolisque dense tomentellis, trichomiis stramineis val pallide brunneis ca. 0.8–0.9 mm longis; foliis maturis glabris, juvenilis tomentellis; petiolis 20–30 mm longis, glabrescentibus, supra canaliculatis glabris; laminis ellipticis coriaceis 7–15 cm longis 3.5–7 cm latis base apiceque rotundatis vel paullo emarginatis, marginibus paullo revolutis, costa media prominente, nervis lateralis 5–9 (–12) per latere unico, cum nervo marginale continuo vel paullo arcuato intra margine 1–2 (–5) mm coalitis; inflorescentiis cymosis (3–) 5–7-floriferis longe-pedunculatis tomentellis, pedunculis 12–38 mm longis ad nodo primo, 1–2-nodosis, bracteis oppositis lanceolatis 1.5–2.5 mm longis concavis; axibus majoribus 5–14 mm longis; pedicellis 2–5 mm longis; floris masculis pro genere magnis sepalis ad 5.5–6 mm longis et ca. 4.5 mm latis, extus hirsutulo-ciliolulatis intus

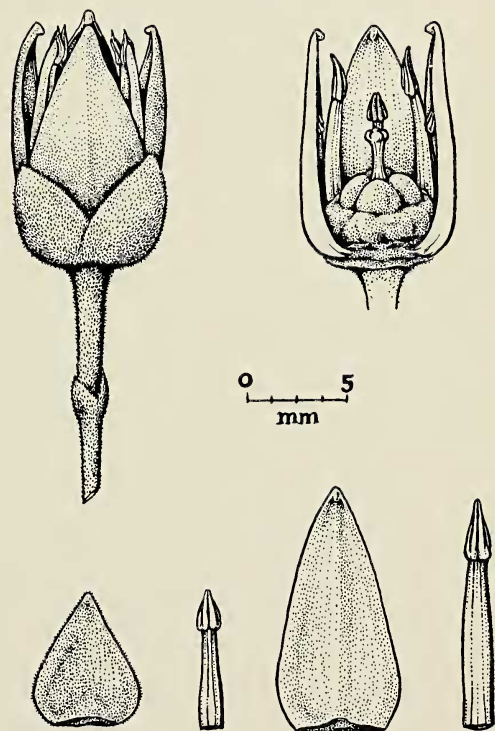


FIG. 2. *Pelea Lobiauana* Stone. Staminate flowers and floral parts of Degener 23984.

glabris, deltoideis, 7–9-nervatis; petalis toto glabris sparse obscure punctatis ovato-lanceolatis ca. 11 mm longis et 5 mm latis apice intus unguiculatis; staminibus fertilibus 8, (4 ad 10 mm longis, 4 ad 7.5 mm longis, antheris 1.7–1.8 mm longis, filamentis ligulatis ca. 1 mm latis); ovario glabro ca. 2 mm alto, disco glabro ca. 1 mm alto; stylo ca. 2 mm longo, stigma ca. 1.4 mm lato lobis rufidis minute papillatis cruciatis; floris foemeneis minoris sepalis ca. 3.5 mm longis et 3 mm latis, petalis ca. 7–8 mm longis et 3.5 mm latis, staminibus sterilibus ca. 2 mm longis subaequantibus; ovario discoque glabro, stylo glabro ca. 4 mm longo; capsulis quadrilobatis, glabris, ad 20–25 mm diametro, endocarpio glabro.

HOLOTYPE: Kauai: Kokee, August 1924, *Degener* 8586 (Bishop; duplicates at Cath, NY).

DISTRIBUTION: Kauai, in the Waimea highlands.

SPECIMENS EXAMINED: Kauai: Near Lehua-makanoe Bog, 18 September 1955, *Degeners, Hansen & Hanner* 23984 (Bishop; staminate fls.). Kaholuamano, October 1895, *Heller* 2869 (formerly determined as *P. resiniflora*) (GH, EDINB, US). Halemano, 14 February 1909, *Rock* 2294 (A). Waialeale, October 1911, *Rock* (A). Kaholuamano, September 1909, *Rock* 5551 (A, Bishop), 5552 (GH, Bishop).

This is by no means a complete citation of specimens; more are extant, particularly in the Bishop Museum, but many lack data, particularly localities and collectors' numbers. Most of these specimens had been determined as *Pelea macropus* Hillebr., which however is quite distinct in having puberulent ovaries (and hence capsules) and clavoid pedicels. Because of this interpretation, this species has consistently been mistaken for *P. macropus*, and this error has tended to obscure knowledge of both of them. The glabrous endocarp and rotate capsular lobes place *P. Lohiauana* in a group with *P. oblanceolata* St. John (of Hawaii), *P. manukaensis* St. John (of Hawaii), and *P. pseudoanisata* Rock (of Hawaii).

The specific name honors Prince Lohiau of Kauai, hero of the tales of Pele and Hiiaka, and one of the memorable characters of Hawaiian mythology.

8. *Pelea macropus* Hillebrand, Fl. Haw. Ids. 65, 1888.

*P. acutivalvata* Léveillé in Fedde Repert. Sp. Nov. 10:153, 1911.

Innovations minutely and closely pale cinereous-puberulent, hairs appressed, ca. 0.2 mm long; branchlets at youngest nodes cinereous but soon glabrate; leaves glabrous ventrally, at first minutely cinereous dorsally (mostly on the costa), but soon glabrate, the older leaves mostly quite glabrous; petioles soon glabrate. Leaves opposite, the petioles mostly 9–15 mm long; blades thinly coriaceous, rounded or emarginate at apex, contracted and subcuneate at base (the margins sometimes slightly revolute); costa ventrally pale, shallow-sulcate; dorsally pale and prominent with a rather sparse and minute ephemeral puberulence; lateral nerves at right angles to costa or slightly ascending, about 7–9 per side, conspicuous, prominulent on both surfaces, connected at a distance of 2–10 mm from the margin by a moderately to deeply arcuate marginal nerve, with several sets of intervening meshes. Inflorescences small, axillary or ramulose, mostly 1–3-flowered, the peduncle very short, about 1–5 mm long, bibracteolate at apex, puberulent, the bractlets deltoid, rounded, 0.5 mm long, puberulent; axes minutely cinereous, short (to 5 mm) in flower, somewhat elongated in fruit; pedicels 2–5 mm long, flared at base of calyx and clavoid, bibracteolate, cinereous; pistillate flowers with broadly deltoid sepals about 1.5 mm long and 1.7 mm broad, minutely puberulent externally; petals about 2.5 mm long and 1.7 mm broad, with a faint close puberulence of few minute hairs along the midregion, glabrous within; rudimentary stamens glabrous, less than 1 mm long; disk reddish, glabrous, shallow, ca. 1.7 mm broad; ovary puberulent, ca. 1 mm high and 1 mm broad; style glabrous, ca. 1.6–1.7 mm long (including stigma), stigma lobes red, each 0.25 mm long, minutely papillate, obovoid. Capsules 25–35 mm diameter, about 9 mm high, sparsely appressed-puberulent (especially near the base), the lobes deeply separated ( $\frac{5}{6}$ ), somewhat acuminate and laterally compressed, often unequally developed; endocarp glabrous, cartilaginous; seeds 5–6 mm long, ovoid, the testa crustaceous, blackish.



HOLOTYPE: Kauai: Waimea, *Knulsen* 189 (Berlin; now destroyed).

DISTRIBUTION: Kauai.

SPECIMENS EXAMINED: Kauai: "Robinson's summer house," February 1910, *Faurie* 172 (type of *P. acutivalvata*; type at Edinburgh; isotype at A). Waimea, Kaholuamano, October 1895, Heller 2870 (BM, K. Paris, US).

The description given above sufficiently distinguishes *Pelea macropus* from the newly described *P. Lohiauana*.

#### SECTION *Cubicarpa* STONE

9. *Pelea peduncularis* Lévillé in Fedde Repert. Sp. Nov. 10:443, 1912.

Fig. 3

*P. sandwicensis* var.  $\beta$  sensu Hillebrand, Fl. Haw. Ids. 66, 1888 (not *P. sandwicensis* [Hook. f. & Arn.] Gray).

*P. sandwicensis* var. *macrocarpa* Hillebr. ex Rock in Bot. Gaz. 65:265, 1918.

*P. nodosa* Lévillé in Fedde Repert. Sp. Nov. 10:443, 1912.

*P. grandipetala* Lévillé l.c. (in part; specimen typicum mixtum; in part *P. honoluluensis*). Syn. nov.

*P. singuliflora* Lévillé l.c. (in part; see *P. Wawraeana*). Syn. nov.

*P. Rockii* St. John in Lloydia 7:271, 1944. Syn. nov.

A small or sometimes shrubby tree, the innovations finely scurfy and somewhat sparsely cinereous-puberulent; trichomes soon caducous, the mature branchlets and leaves glabrous, or the petioles sometimes puberulent then glabrate. Leaves petiolate, opposite; petioles 13–40 mm long, lenticellate in age especially at the extremities; blades coriaceous, elliptic, rounded to slightly emarginate at apex and at base, mostly 3–18 cm long and 2–11 cm broad (commonly  $5-9 \times 3-6$  cm), darker above, the margin near the base usually tightly revolute; midrib above sulcate, raised beneath, often reddish or purplish; major lateral nerves mostly about 7–10 per side, united distally by a slightly sinuate marginal nerve close to (about 1–5 mm from) the margin. Inflorescence a pedunculate usually 5–21-flowered minutely cinereous glabrate cyme often

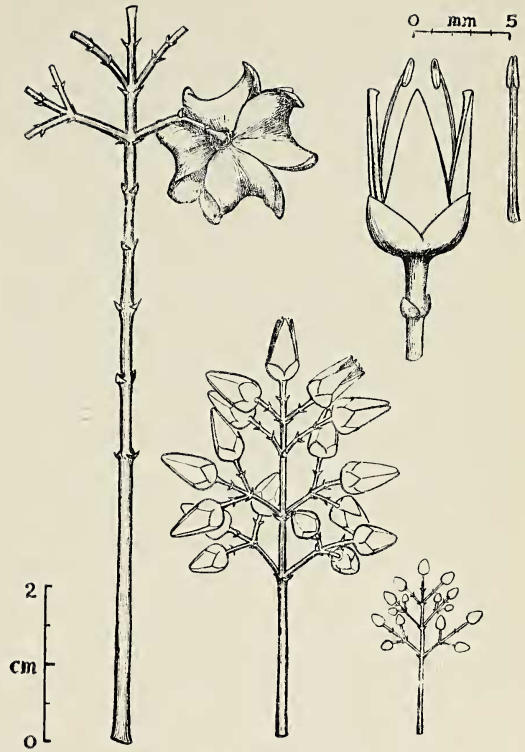


FIG. 3. *Pelea peduncularis* Lév. Inflorescences; at left, a long inflorescence with a dehiscent capsule, from *Faurie* 189 (isotype); at right, inflorescences in flower and in bud from Rémy 621, with enlarged view of one staminate flower.

longer than the adjacent petiole, the peduncle up to 4 cm long and with as many as 8 nodes, but usually about 3–4-nodose, stout (1–2 mm thick), the pedicels short and stout, 3–4 mm long, the bractlets lanceolate, the upper ones deltoid, minutely ciliolate and sparsely puberulent, 1–3 mm long; pistillate flowers with sparsely scurfy-puberulent deltoid-ovate sepals about 2 mm long and 1.8 mm broad, lanceolate-ovate glabrous punctate petals about 5 mm long, reduced sterile stamens barely higher than the glabrous 4-lobed ovary, the disk glabrous, the style filiform reddish about 2 mm long, the stigmas 0.5 mm long, slightly clavate and minutely papillate, rotate. Staminate flowers similar but larger, the petals about 7 mm long, the gynoecium much reduced, the fertile stamens longer, in 2 subequal quartets, the longer stamens about 8 mm long. Capsules mostly about

20–25 mm broad and 10 mm high, quadrate or slightly lobed (less than or barely halfway), the exocarp glabrous, punctate, mostly dark green or tinged with dull reddish-purple; endocarp pale and glabrous; seeds mostly 2 per cell; carpels after dehiscence reflexed in age, the axis persistent only at the extreme base.

TYPE: Oahu: Koolau Range, Kalihi, October 1909, *Faurie* 189 (Edinburgh; isotype at Paris).

DISTRIBUTION: Restricted to Oahu; found on both the Waianae and Koolau mountain ranges.

This common Oahu species has been misinterpreted since it was first described. This is not surprising, however, since the confusion involved with the identity of the true *Pelea sandwicensis* (H. & A.) Gray had obscured the concept greatly, and since Lévillé himself did nothing to clarify the species, and presumably did not realize that the other "species" so briefly and inadequately described by him were either the same or mixtures (the type specimens often being composed of branchlets clearly from two or three different species). In addition, some rather clearly defined varieties of the species occur in particular areas of Oahu, and some of these have been described as distinct species. Dozens of collections from various localities both in the eastern and western mountain ranges are known. A few representative specimens are cited here; full citation of specimens will be presented in the forthcoming monographic treatment.

SPECIMENS EXAMINED: Oahu: Koolau Range: Pupukea, January 1927, *MacDaniels* 547 (Bishop); February 1928, *Degener & Shear* 8580 (NY, Catholic, US). Kalihi, October 1909, *Faurie* 190 (BM). Konahuanui, *Faurie* 194 (BM, isotype of *Pelea singuliflora*). Manoa-Pauoa hills, April 1861, *Hillebrand* 237 (Kew). Nuuanu,

May 1861, *Hillebrand* 238 (Kew). Nuuanu-Kalihi ridge, August 1922, *Skottsberg* 173 (Goth, Kew); Niu, *Hillebrand* 1797 (US, isotype of *Pelea molokaiensis*  $\beta$  var. Hbd.). Waianae Mountains: Puu Kaala, *Mann & Brigham* 600 (Cornell, Kew). Makaha Valley, Feb. 1909, *Forbes* (Bishop). Puu Kanehoa, May 1960, *Stone* 3268 (Bishop, Goth, Kew, Leiden, US). Without locality: *Mann & Brigham* 208, in part (Cornell). *Rémy* 621 (Paris, 3 sheets).

(a) var. *peduncularis*

Fig. 3

Found mostly along the southern stretches of the Koolau Range, from Punaluu down through Waialae and Niu valleys. The typical variety, easily confused with *Pelea oahuensis* Lév. and sometimes with *Pelea Wawraeana* Rock, but differing in many respects from both; from the former in the larger and flatter capsules, the more ample and stouter cymes, and generally larger vegetative parts, and the larger reddish (not yellowish) flowers; and from the latter in the larger capsules with glabrous endocarp, and mostly glabrous petioles and branchlets as well as cymes.

(b) var. *niuensis* (St. John) B. C. Stone, comb. nov.

*Pelea niuensis* St. John in *Lloydia* 7:272, 1944.

Branchlets glabrate; petioles glabrate; blades narrowly elliptic or oblong-elliptic, glabrous, 6–12 cm long and 2–5 cm broad; inflorescences commonly 7–9-flowered, glabrous; capsules nearly quadrate when fresh, slightly lobate when dry, 21–25 mm broad and about half as high, glabrous; endocarp glabrous.

#### KEY TO VARIETIES OF *Pelea peduncularis*

1. Capsules slightly lobed (up to halfway), green, usually dull, sometimes reddish; blades elliptic to elliptico-oblong.
  2. Leaves opposite.
    3. Blades very narrowly oblong-elliptic.....var. *niuensis*
    3. Blades elliptic to broadly oblong-elliptic.
      4. Cymes mostly 7–21-flowered.....var. *peduncularis*
      4. Cymes mostly 3–7-flowered.....var. *pauciflora*
  2. Leaves whorled in fours.....var. *paloloensis*
1. Capsules unlobed, quadrate, dark glossy green.....var. *quadrata*



**HOLOTYPE:** Oahu: Koolau Range; Niu, October 1940, *St. John 20111* (Bishop).

**DISTRIBUTION:** Endemic to the southeastern-most part of the Koolau Range.

This variety differs from the typical *P. peduncularis* only in the much narrower leaves and perhaps slightly fewer-flowered cymes.

**SPECIMEN EXAMINED:** Oahu: Northeast slope of Puu Kumakalii, April 1936, *Degener, Tam, Takamoto & Martinez 10579* (Bishop, Catholic, NY).

(c) var. *pauciflora* (St. John) B. C. Stone, comb. nov.

*Pelea Rockii* var. *pauciflora* St. John in *Lloydia* 7:271, 1944.

Cymes mostly 3–7-flowered.

**HOLOTYPE:** Oahu: Koolau Range; Kaukonahua Gulch, Wahiawa, May 1909, *Rock 3046* (Bishop).

**DISTRIBUTION:** Known only from the type locality.

A poorly defined variety which may be only an anomalous form of the species.

(d) var. *paloloensis* (St. John) B. C. Stone, comb. nov.

*Pelea paloloensis* St. John in *Lloydia* 7:271, 1944.

Leaves whorled in fours at the nodes.

**HOLOTYPE:** Oahu: Koolau Range; Palolo, Waialae-iki, Jan. 1917, *Forbes 2404.O.* (Bishop).

**DISTRIBUTION:** Known only from the type locality.

The variety, which probably is nothing more than an anomalous form, is an example of the occasional exception to the common taxonomic criterion for distinguishing species which are members of the section *Pelea*, with ordinarily whorled leaves, and the other sections, with generally opposite leaves.

(e) var. *quadrata* B. C. Stone, var. nov.

Fig. 4

Capsulis elobatis quadratis fere ca. 25 mm latis.

**HOLOTYPE:** Oahu: Waianae Mountains; Puu Hapapa, August 1932, *Degener 8521* (Bishop).

**DISTRIBUTION:** Known from the northern end of both ranges of Oahu.

A characteristic variety, found both in the northern Waianae mountains and in the northern Koolau Range (as for instance around Pupukea), sometimes occurring in company with the typical variety.

10. *Pelea olowaluensis* St. John in *Lloydia* 7:266, 1944.

A tree up to 3 m high, the branchlets at first puberulent; leaves opposite; petioles glabrous; blades 2.8–8 cm long, oval, subcoriaceous, glabrous; cymes mostly 3-flowered, glabrous, the peduncle ca. 9 mm long; capsules 16–20 mm broad, flattened, lobed halfway or less, glabrous; endocarp glabrous.

**HOLOTYPE:** Maui: Olowalu Valley, on the central ridge, May 1920, *Forbes 2326.M.* (Bishop).

**DISTRIBUTION:** West and East Maui.

**SPECIMEN EXAMINED:** West Maui: Mauna Huuma, May 1910, *Forbes & Cooke 22.M.* (Bishop).

This species is closely allied to *Pelea peduncularis* of Oahu and falls properly into section *Cubicarpa*. The characteristically revolute basal leaf-margins are especially noticeable. When fresh the capsules might perhaps be unlobed or barely notched. The disjunction of the two collections would imply that the species is, or was, fairly widespread on Maui.

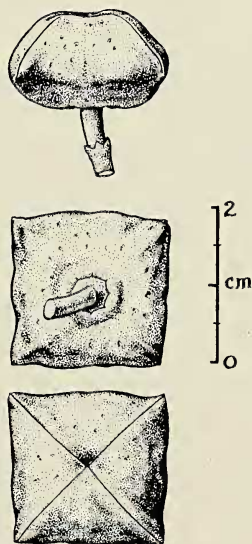


FIG. 4. *Pelea peduncularis* var. *quadrata* Stone. Three views of a capsule in the fresh state, from Stone 2832 (Pupukea, Oahu).

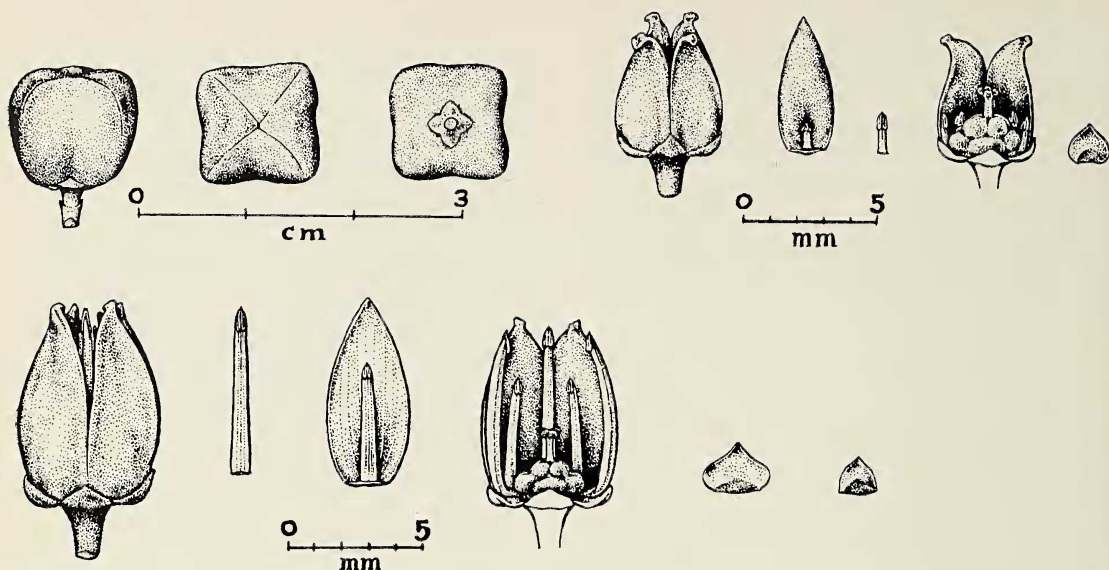


FIG. 5. *Pelea oahuensis* Lévl. emend. Stone. Neotype, Stone 3282. Above, capsules and pistillate flowers; below, staminate flowers.

11. *Pelea oahuensis* Lévillé in Fedde, Repert. Sp. Nov. 10:442, 1912, emend. B. C. Stone.

Figs. 5, 6

A small to middle-size tree, pungent of anise, with glabrous reddish branchlets and opposite leaves; innovations scurfy, the waxy white ephemeral scales mostly concealing an extremely minute sparse puberulence of white hairs usually less than 0.2 mm long, ephemeral also, the older leaves and branchlets glabrous except for a few rare hairs persisting in the axils or on the dorsal midrib near the base; leaves petiolate, the petioles mostly 6–20 mm long, reddish in age, glabrous, flattened ventrally, lenticellate; blades thin coriaceous, mostly (3)–4–12 cm long and 2.5–7 cm broad, glabrous and moderately veiny, darker above, moderately shining, mostly elliptico-obovate, rounded to slightly emarginate at both ends, the costa pale and shallowly canaliculate toward the base ventrally, beyond prominent, beneath raised and reddish; lateral main nerves slightly curvate-ascendent, joined marginally by a lightly arched or nearly straight nerve about 1–5 (–9) mm from the edge. Inflorescence cymose, mostly 3–5-flowered (rarely with 7

flowers), rather short (less than 2 cm long), on short glabrous greenish sometimes scurfy peduncles 3–4 mm long, bibracteolate at apex (the bracteoles minute, deltoid, minutely puberulent or glabrous); axes about 2–3 mm long, similar to peduncles; pedicels about 3 mm long, bibracteolate near the middle or above; flowers functionally staminate or functionally pistillate, or perfect, frequently with both staminate and perfect flowers on the same plant; pistillate flowers greenish, petals yellowish-green; sepals deltoid-ovate, about  $1.8 \times 1.8$  mm, the margins minutely ciliolulate, otherwise glabrous; petals 4.5–5.5 mm long and 2 mm broad, glabrous; stamens rudimentary, about 1 mm long (sometimes in two slightly unequal quartets); ovary and disk glabrous, punctate, the disk about 2.8 mm broad and nearly 1 mm high, the ovary about 2 mm broad and 1 mm high; style slender, glabrous, about 2 mm long including the 4-lobed stigma; staminate and perfect flowers similar but the stamens greatly elongated, the longer quarter as long as the petals; petals slightly longer than those in pistillate flowers, and the ovary and disk greatly reduced, the style short, only 1 mm long. Capsules subcuboid, 10–14 mm broad, about 9 mm high, unlobed or nearly so,



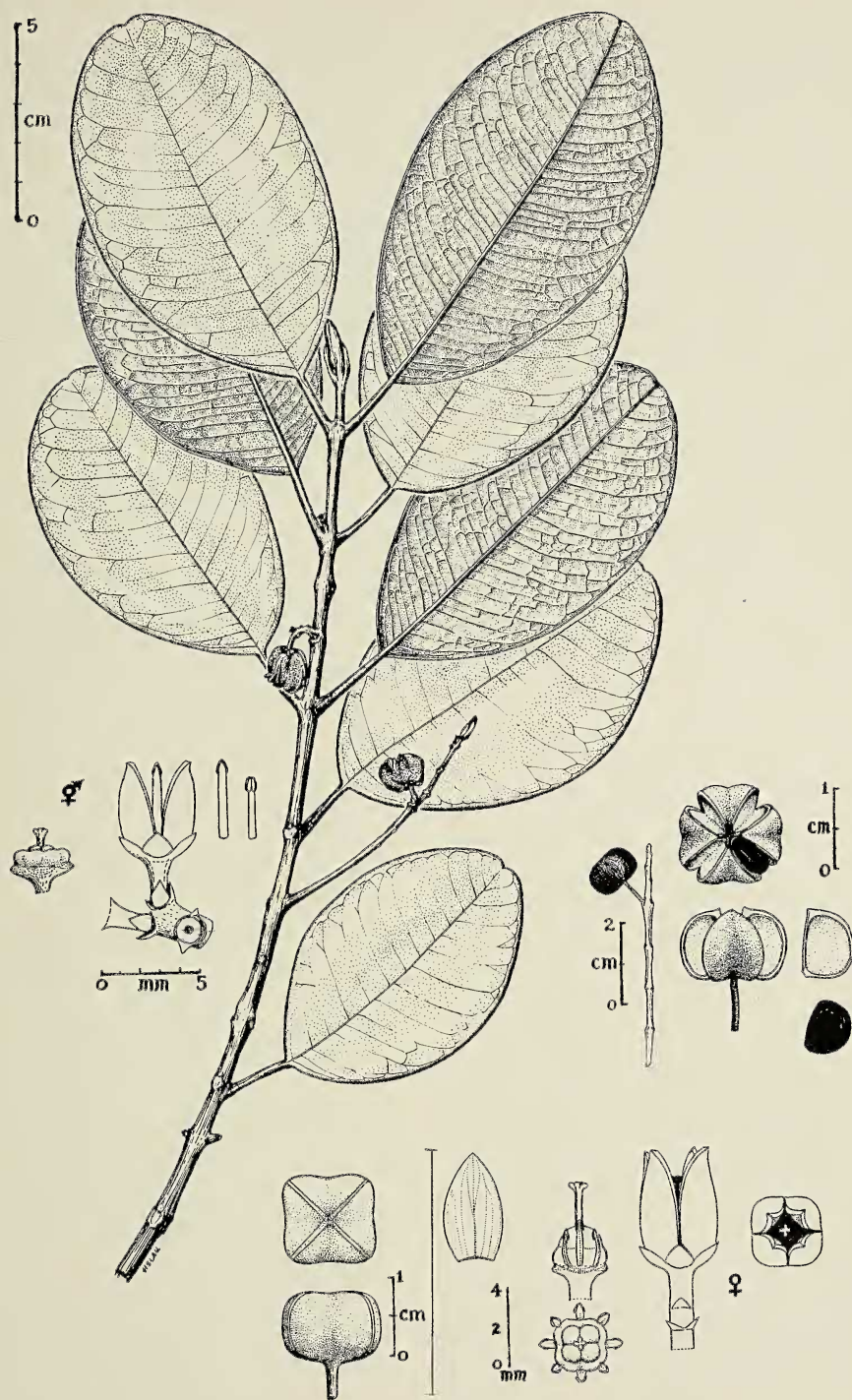


FIG. 6. *Pelea oahuensis* Lévl. emend. Stone. Habit of fruiting specimen, from *Stone* 2805 (Pupukea, Oahu). At left, perfect flower from *Lane* 243 (Pupukea). At right, above, capsules and seed from *Stone* 3200 (Kaala, Oahu). At right, below, capsule and pistillate flower from *Stone* 2826 (Pupukea).

quite glabrous, often pale, greenish, or after dehiscence brown, dehiscent along the upper and lateral sutures; endocarp glabrous, pale, thin, late detaching; seeds often only one per carpel; testa crustaceous, shining black.

TYPE: L  veill   cites three specimens, all from Kalihi, Oahu, collected by Faurie: numbers 11, 217, and 217*bis*. No type is designated. A search was made for these specimens in the herbaria of the Bishop Museum, the British Museum, the Royal Botanic Gardens at Kew and at Edinburgh, the Museum d'Histoire Naturelle, Paris, Gothenburg Botanical Garden, U. S. National Museum, Gray Herbarium, Arnold Arboretum, Cornell University, etc., but without avail. Many of L  veill  s "types" are at Edinburgh or at the British Museum, but none of the cited specimens can be located. The original description is so short and noncommittal that alone it is meaningless: "Affinis praecedenti a quo tantum differt foliis longius 10-25 mm petiolatis, oppositis; petiolo nec rugoso, nec vulnerato, corymbis 2-5 floris, pedicellis bis bibracteolatis, apice incrassatis."

Rock (1914) reduced *Pelea oahuensis* to *P. molokaiensis* Hbd.  $\beta$  var. Hbd., on the basis of Faurie 217, which perhaps was at the Berlin Museum. The preceding species to which L  veill   refers in the above description is his own *Pelea waianaiensis*, which is more fully described. It is based on a single number (Faurie 215, isotype at Bishop), and is apparently a form of *Pelea peduncularis* L  vl. The reference, however, is helpful in interpreting the present species, as the two are similar in appearance.

In the absence of any type material, it seems necessary to designate a neotype, which would of course be replaced by original material should any turn up. The species, as interpreted here, is a very distinct and common one on Oahu, and is the Oahuan counterpart of the "moki-hana" or *Pelea anisata* Mann of Kauai; the same strong anisate odor is present in all parts, the flowers and fruits are very similar, and the specific differences are mainly in characters of the leaves and habit. There are a great many collections of this species, most of which have been determined as *Pelea Wawreana* Rock, which is, however, a very different species of

Sect. *Megacarpa*. The following collection may be selected as neotype:

NEOTYPE: Oahu: Waianae Mountains; Kunia trail, 26 March 1960, B. C. Stone & G. Pearsall 3282 (Bishop; duplicates to be distributed).

DISTRIBUTION: Endemic to Oahu. This is a very common species on both the Waianae and Koolau ranges. It may be identified in the field by its strong anise fragrance, very short essentially glabrous 3-5-flowered cymes with small greenish flowers, and small cuboid green or whitish-green capsules. In the Waianae Mountains it occurs in company with *Pelea peduncularis*, *P. kaalaensis*, *P. clusiaefolia* var. *crassiloba*, and *P. elliptica*.

## REFERENCES

- HELLER, A. A. 1897. Observations on the ferns and flowering plants of the Hawaiian Islands. Minnesota Bot. Studies 9:760-922, pls. 42-69.
- HILLEBRAND, W. 1888. Flora of the Hawaiian Islands. Heidelberg, London, & New York. i-xciv, 1-673.
- ROCK, JOSEPH F. 1914. Revisio plantarum Hawaiiensium a L  veill   descriptarum. Repert. Sp. Nov. ed. Fedde 13:352-361.
- 1918. *Pelea* and *Platydesma*. Bot. Gaz. 65:261-267.
- SKOTTSBERG, C. 1944. Vascular plants from the Hawaiian Islands, IV. Phanerogams collected during the Hawaiian Bog Survey 1938. Acta Horti Gotob. 15:275-531.
- STONE, B. C. 1962*a*. Studies in the Hawaiian Rutaceae, I. Taxonomic and nomenclatural notes on *Platydesma* (Hawaii) and *Melicope* (Solomon Islands). Madro  o 16:161-166.
- 1962*b*. Studies in the Hawaiian Rutaceae, II. On the identity of *Pelea sandwicensis*. Pacif. Sci. 16:366-373.
- 1962*c*. Studies in the Hawaiian Rutaceae, III. On the New Caledonian species of *Pelea*, and a misunderstood species of *Platydesma*. *Adansonia* (Paris): 1, 2:94-99.
- 1962*d*. Rutaceae: Genus *Pelea*. In: O. Degener, Flora Hawaiiensis. Honolulu (privately printed).